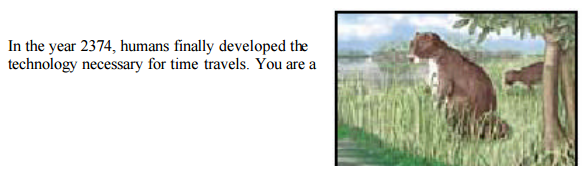
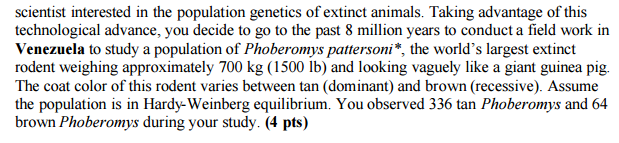
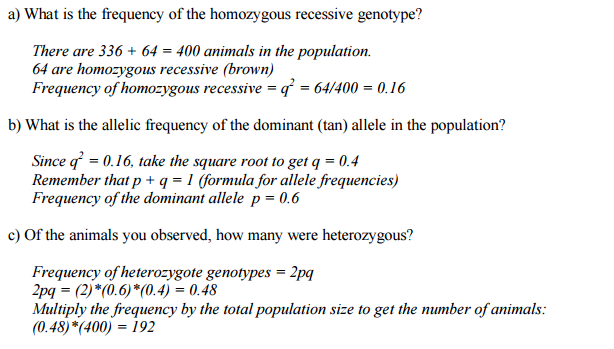
**Example Chi Square Problems Involving Hardy Weinberg Equilibrium and Genetics**

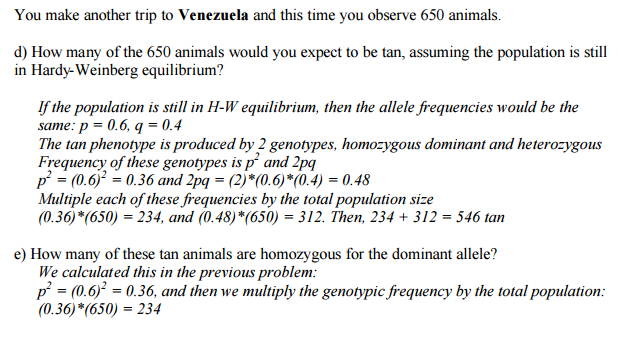
*Thank you to Michigan State University!*

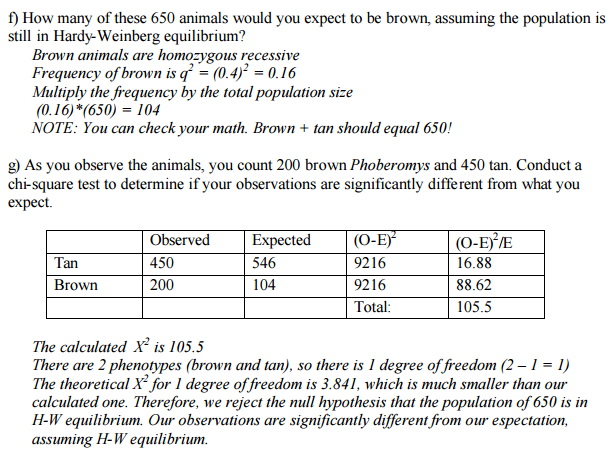
**Example Chi Square Problem Involving Hardy Weinberg Equilibrium:**











**Notes:**

1. By “theoretical X2”, they are referring to the critical value given in a critical values table (at a p value of 0.05 and the appropriate degrees of freedom)
2. The null hypothesis can be restated as… “There is no statistically significant difference between the observed numbers of tan vs. brown animals compared to the expected numbers of tan vs. brown animals predicted by Hardy Weinberg Equilibrium.”

**Example Chi Square Problem Involving Genetics:**

In fruit flies, red eyes (E) are a dominant trait and sepia eyes (e) are a recessive trait. These alleles are carried on a non-sex chromosome (i.e. an autosome).

If pure-bred red-eyed male flies are crossed with sepia-eyed female flies, all the offspring in the F1 generation are red-eyed. If these offspring are crossed, the F2 generation shows the following results.

**F2 Generation**

|  |  |
| --- | --- |
| **Eye Color** | **Number of Flies** |
| Red | 742 |
| Sepia | 231 |

These are our observed results for the F2 generation. Now we want to determine the expected results for our F2 generation based on the rules of Mendelian Inheritance.

Using Punnett Squares, if we cross pure-bred red-eyed males (EE) with sepia-eyed females (ee), we will see 100% sepia-eyed offspring in the F1 generation (see Punnett Square below)

|  |  |  |
| --- | --- | --- |
|  | E | E |
| e | Ee | Ee |
| e | Ee | Ee |

If we cross the red-eyed offspring (Ee) from the F1 generation, we will see 75% red-eyed and 25% sepia-eyed offspring in the F2 generation (See Punnett Square below)

|  |  |  |
| --- | --- | --- |
|  | E | e |
| E | EE | Ee |
| e | Ee | ee |

These are our expected FREQUENCIES, but we cannot use these percentages / decimal values as our “e” values in the Chi square equation. Instead we need to use these frequencies to predict the whole number of red-eyed and sepia-eyed flies we would expect in the F2 generation based on the total number of flies observed in the F2 generation. Therefore we can calculate our values for “e” using the following method.

Total # of Flies in the F2 Generation = 231 + 742 = 973

# of Flies Expected to Have Red Eyes in the F2 Generation = 0.75 x 973 = 730

# of Flies Expected to Have Sepia Eyes in the F2 Generation = 0.25 x 973 = 243

We can then use our observed (o) and expected (e) values for the F2 generation to calculate X2 using the formula and the chart given below:



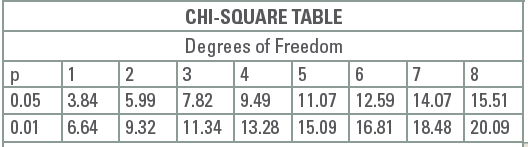
|  |  |  |  |
| --- | --- | --- | --- |
| **Phenotype** | **# Observed (o)** | **# Expected (e)** | **(o-e)2 / e** |
| Red Eyes | 742 | 730 | [(742-730)2 / 730] = 0.1973 |
| Sepia Eyes | 231 | 243 | [(231-243)2 / 243] = 0.5926 |

Total (add the values in the last column) = **X2 value** = 0.79

Next, we need to determine the number of degrees of freedom. Degrees of freedom is calculated using the formula (n-1), where “n” is the number of sets of data. In this case, we have two sets of data (i.e. two different eye colors), so this corresponds to 1 degree of freedom.

Now, we can look at the critical values table given below to determine the critical value at a p value of 0.05 and 1 degree of freedom. According to the chart, our critical value is 3.84.

*(Note: Scientists almost always use a p value of 0.05).*



Because our calculated X2 value (0.79) is lower than the critical value (3.84), we fail to reject (i.e. support) our null hypothesis. The null hypothesis for this experiment is given below.

Null Hypothesis: There is no statistically significant difference between the observed F2 generation results and those expected based on known patterns of Mendelian inheritance.

*(Note: By failing to reject the null hypothesis, we are tentatively stating that our observed results of the number of flies with red vs. sepia eyes in the F2 generation appear to match the frequencies predicted by Punnett Squares.)*